Letters to the Editor

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INCREASE IN BREAKDOWN POTENTIAL OF A GAS IN ELECTRODELESS DISCHARGE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD AND THE CONCEPT OF EQUIVALENT PRESSURE

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The properties of electrical discharge in the presence of a uniform transverse magnetic field has been investigated by a large number of workers (Wehrli 1922, Somerville 1952, Blevin and Hydon 1958, Huxley, 1957). It has been shown that for a weakly ionised gas, a large variety of phenomena can be explained if, instead of the actual pressure p, use is made of an equivalent pressure p' defined by (Blevin and Haydon, 1958)

$$p' = p\sqrt{1+C\left(\frac{H}{p}\right)^2} \qquad \dots \quad (1)$$

where p', p are pressure in mm. of Hg, $H =$ magnetic field, $C = \left(\frac{l}{m} \cdot \frac{L}{u}\right)^2$ L being the mean free path at 1mm. Hg and u the mean electron velocity.

Experimental results can, however, be explained equally satisfactorily from other points of view. Thus, Dev and the author (Deb and Goswami, 1956) in course of study of the low frequency electrodeless discharge in a tube in the presence of a transverse static magnetic field has shown from an elementary consideration that the break-down potential in a gas should increase on application of the magnetic field. It was further shown that to a first approximation the increased breakdown potential V' is given by

$$\frac{V'-V}{V'} = 1-\cos\theta \qquad \dots \quad (2)$$

where V', V are the breakdown potentials with and without the magnetic field respectively and θ is the angular deflection of the electronic path due to the magnetic field given by

$$\theta = \frac{He\lambda}{m\bar{v}} = \frac{HeL}{m\bar{v}p} \qquad \ldots \quad (3)$$

The purpose of this note is to point out that the concepts of equivalent pressure and of increased breakdown potential are fundamentally the same and that Eq.(1) may be driven from (2) if certain plausible assumptions are made. Thus for a high pressure discharge tube, at least, it is reasonable to assume that the breakdown potential is proportional to the pressure (Loeb, 1939). Further, for such pressure and moderate values of H the angular deflection θ is small enough to justify the assumption $\tan\theta = \theta$. Hence, under these conditions, one can obtain from Eq. (2)

$$\frac{p'-p}{p'} = 1 - \cos\theta$$

or

$$p'/p = \sec\theta \sim \sqrt{1+\theta^2}$$

or

$$p' = p\sqrt{1+C\left(\frac{H}{p}\right)^2} \quad \text{where} \quad C = \left(\frac{e}{m}\cdot\frac{L}{u}\right)^2,$$

which is Eq (1).

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